CLAIMS

What is claimed is:

1. A method for treating metal working fluid, comprising the steps of:
transferring the metal-working fluid into a heating vessel;
heating the metal-working fluid in the heating vessel to maintain the metal-working fluid at an elevated temperature during a heating period;
agitating and aerating the metal-working fluid during at least a portion of the heating period;
transferring the metal-working fluid out of the heating vessel into a holding vessel after the heating period; and
transferring the metal-working fluid out of the holding vessel.
2. The method of Claim 1 wherein the heating vessel is provided with a heating element.
3. The method of Claim 2, wherein the heating element comprises a closed-loop recirculating heater with a finned heating tube positioned within the heating vessel.
4. The method of Claim 1, further comprising the step of cooling the metal-working fluid in the holding vessel.
5. The method of Claim 4, wherein the holding vessel is provided with a cooling element.
6. The method of Claim 5, wherein the cooling element comprises a finned cooling tube positioned within the holding vessel and a source of coolant.
7. The method of Claim 6, wherein the coolant is cooled air.
8. The method of Claim 7, wherein the source of coolant is a vortex tube for cooling the air.
9. The method of Claim 1 wherein the elevated temperature is between about 145° F and about 210° F and the heating period is longer than about 30 minutes.
10. The method of Claim 9, wherein the heating period is longer than about 60 minutes and the elevated temperature is about 160° F.
11. The method of Claim 1, wherein a bottom portion of the heating vessel is provided with air inlets and air flow through the inlets and through the metal-working fluid agitates and aerates the metal-working fluid.
12. The method of Claim 11, wherein the air flow through the metal-working fluid is heated prior to flowing through the metal-working fluid.
13. The method of Claim 11, wherein the air flow through the metal-working fluid flows out of the heating vessel through a de-mister.

14. The method of Claim 13, wherein the de-mister comprises a centrifuge impactor.
15. The method of Claim 11, wherein the air flow through the metal-working fluid flows out of the heating vessel through a filter.
16. The method of Claim 15, wherein the filter comprises a charcoal filter.
17. The method of Claim 11, wherein air flows through the inlets and through the metal-working fluid by application of negative pressure to an air volume above the metal-working fluid in the heating vessel.
18. The method of Claim 17, wherein negative pressure applied to the air volume above the metal-working fluid in the heating vessel is supplied by at least one of a centrifuge impactor and an air flow amplifier.
19. The method of Claim 1, wherein the metal-working fluid is transferred into the heating vessel by applying negative pressure to the heating vessel.
20. The method of Claim 19, wherein negative pressure for transferring the metal-working fluid into the heating vessel is supplied by an air flow amplifier.
21. The method of Claim 1, wherein the metal-working fluid is transferred out of the holding vessel by applying positive pressure to the holding vessel.
22. The method of Claim 21, wherein positive pressure for transferring the metal-working fluid out of the heating vessel and into the holding vessel is supplied by a pressure regulator.
23. The method of Claim 1, wherein the metal-working fluid is transferred out of the heating vessel and into the holding vessel by at least one of: i) applying positive pressure to the heating vessel; and ii) applying negative pressure to the holding vessel.
24. The method of Claim 23, wherein negative pressure for transferring the metal-working fluid out of the heating vessel and into the holding vessel is supplied by an air flow amplifier.
25. The method of Claim 23, wherein positive pressure for transferring the metal-working fluid out of the heating vessel and into the holding vessel is supplied by a pressure regulator.
26. The method of Claim 1, further comprising the step of reducing a concentration in the metal-working fluid of at least one metal by passing the metal-working fluid through an ion-exchange filter.
27. The method of Claim 26, wherein one of the at least one metal is cobalt.
28. The method of Claim 26, wherein the ion-exchange filter includes a sulfonated divinyl-benzene-cross-linked polystyrene ion-exchange resin.

29. The method of Claim 26, wherein metal-working fluid from the holding vessel is recirculated through the ion-exchange filter.

30. An apparatus for treating metal working fluid, comprising:
a heating vessel for receiving and holding metal-working fluid for treatment;
a heater for heating the metal-working fluid in the heating vessel;
an agitator for agitating the metal-working fluid within the heating vessel;
an aerator for aerating the metal-working fluid within the heating vessel;
a holding vessel for receiving and holding treated metal-working fluid form the heating vessel; and
a transfer pump for transferring the metal-working fluid from the heating vessel into the holding vessel.

31. The apparatus of Claim 30, wherein the heater includes a heating element provided within the heating vessel.

32. The apparatus of Claim 31, wherein the heating element comprises a closed-loop recirculating heater with a finned heating tube positioned within the heating vessel.

33. The apparatus of Claim 30, further comprising a cooling element provided in the cooling vessel for cooling the treated metal-working fluid.

34. The apparatus of Claim 33, wherein the cooling element comprises a finned cooling tube positioned within the holding vessel and a source of coolant.

35. The apparatus of Claim 34, wherein the coolant is cooled air.

36. The apparatus of Claim 35, wherein the source of coolant is a vortex tube for cooling the air.

37. The apparatus of Claim 30, wherein the agitator and aerator comprise an air flow source and air inlets provided in a bottom portion of the heating vessel so that air flow through the inlets and through the metal-working fluid agitates and aerates the metal-working fluid.

38. The apparatus of Claim 37, further comprising a heater for heating the air flow through the metal-working fluid.

39. The apparatus of Claim 37, further comprising a de-mister, wherein the air flow through the metal-working fluid flows out of the heating vessel through the de-mister.

40. The apparatus of Claim 39, wherein the de-mister comprises a centrifuge impactor.

41. The apparatus of Claim 37, further comprising a filter, wherein the air flow through the metal-working fluid flows out of the heating vessel through the filter.

42. The apparatus of Claim 41, wherein the filter comprises a charcoal filter.
43. The apparatus of Claim 37, wherein the air flow source includes an source of negative pressure applied to an air volume above the metal-working fluid in the heating vessel, thereby drawing ambient air in through the inlets and through the metal-working fluid.
44. The apparatus of Claim 37, wherein the negative pressure source includes at least one of a centrifuge impactor and an air flow amplifier.
45. The apparatus of Claim 30, further comprising an inflow pump for transferring metal-working fluid into the heating vessel by applying negative pressure to the heating vessel.
46. The apparatus of Claim 45, wherein the inflow pump is an air flow amplifier.
47. The apparatus of Claim 30, further comprising an outflow pump for transferring metal-working fluid out of the holding vessel by applying positive pressure to the holding vessel.
48. The apparatus of Claim 47, wherein the outflow pump includes a compressed air source and a pressure regulator.
49. The apparatus of Claim 30, wherein the transfer pump includes at least one of: i) a source of positive pressure applied to the heating vessel; and ii) a source of negative pressure applied to the holding vessel.
50. The apparatus of Claim 49, wherein the source of negative pressure is an air flow amplifier.
51. The apparatus of Claim 49, wherein the source of positive pressure includes a compressed air source and a pressure regulator.
52. The apparatus of Claim 30, further comprising an ion-exchange filter connected to at least one of the heating vessel and the holding vessel for reducing a concentration in the metal-working fluid of at least one metal.
53. The apparatus of Claim 52, wherein one of the at least one metal is cobalt.
54. The apparatus of Claim 52, wherein the ion-exchange filter includes a sulfonated divinyl-benzene-cross-linked polystyrene ion-exchange resin.
55. The apparatus of Claim 52, wherein the ion exchange filter is connected to the holding vessel so as to enable recirculation of metal-working fluid from the holding vessel through the ion-exchange filter.